TABLE 6
GROSS PRIVATE DOMESTIC FACTOR INPUT, 1929–1967 (CONSTANT PRICES OF 1958)

Year	1. Gross Private Domestic Factor Input, Quantity Index	2. Gross Private Domestic Factor Input, Price Index	3. Property Compensation, Relative Share
1929	261.5	0.394	0.455
1930	253.1	0.355	0.428
1931	242.2	0.318	0.439
1932	220.8	0.262	0.423
1933	218.5	0.254	0.441
1934	223.1	0.269	0.414
1935	230.2	0.300	0.446
1936	240.2	0.318	0.438
1937	247.9	0.342	0.422
1938	236.0	0.328	0.413
1939	247.1	0.344	0.424
1940	260.7	0.358	0.434
1941	285.7	0.405	0.439
1942	307.2	0.466	0.431
1943	318.2	0.530	0.428
1944	314.6	0.563	0.418
1945	301.5	0.581	0.410
1946	305.2	0.624	0.395
1947	324.8	0.672	0.391
1948	337.5	0.710	0 391
1949	333.8	0.707	0.392
1950	350.7	0.767	0.419
1951	371.6	0.827	0.423
1951	380.0	0.850	0.415
1953	391.6	0.869	0.404
1954	385.7	0.889	0.415
1955	404.4	0.927	0.422
1956	419.1	0.946	0.410
1957	423.5	0.980	0.408
1958	418.4	1.000	0.414
1959	437.6	1.036	0.414
1960	448.9	1.052	0.410
1961	452.0	1.078	0.416
1962	466.8	1.122	0.422
1963	479.0	1.150	0.425
1964	498.6	1.180	0.425
1965	519.3	1.234	0.434
1966	545.2	1.285	0.433
1967	566.8	1.292	0.422

more slowly than the stock rental price, reflecting increases in the quality of the capital stock. Most of this improvement in quality took place during the period 1948–1967, so that the potential service price follows the capital stock price rather closely during the period 1929–1948. Finally, the relative utilization of capital has grown during the period 1929–1967, so that the actual flow rental price grows more slowly than the potential flow rental price. Most of the growth in relative utilization took place during the period 1929–1948, so that the actual service price follows the potential service price during the period 1948–1967.

Estimates of the responsiveness of factor proportions to relative factor prices also depend on the method of measurement. The average elasticity of

TABLE 7
SOURCES OF GROWTH IN FACTOR INPUT, 1929–1967 (ANNUAL PERCENTAGE RATES OF GROWTH)

	1929–1948	1948–1967	1929–1967
1. Capital input			
a. Stock	0.00	3.24	1.62
b. Quality change	0.30	0.94	0.62
c. Relative utilization	0.89	0.26	0.58
2. Labor input			
a. Stock	0.99	0.89	0.94
b. Quality change	0.59	0.74	0.67
c. Relative utilization	−0.13	−0.11	−0.12

substitution is defined as the ratio of the average rate of growth in capital services relative to labor services to the average rate of growth in the wage rate relative to the capital service price. Estimates of the average elasticity of substitution are given for each of the alternative methods of measurement in Table 9. For the actual flows of labor and capital services, the average elasticity of substitution is −0.25 for the period 1929–1948, 1.30 for 1949–1967, and 0.79 for the period as a whole. For comparison estimates of the average elasticity of substitution based on man-hours of labor and the stock of capital, the conventions used by Solow and subsequently adopted by Arrow, Chenery, Minhas, and Solow, are −0.20 for the period 1929–1948, 1.35 for 1948–1967, and 0.77 for the period as a whole.[34]

It is useful to compare the growth of product prices with the growth of factor costs. Price indexes for investment and consumption goods product are given in Table 3 above. The price of investment goods product grows at the rate of 2.22 per cent per year from 1929–1948, 1.81 per cent from 1949–1967, and 2.02 per cent for the period as a whole. The corresponding rates of growth for the price of consumption goods product are 2.22 per cent per year from 1929–1948, 1.97 per cent from 1948–1967, and 2.05 per cent for the period as a whole. Estimates of the responsiveness of the composition of output to relative prices of these two types of product may be obtained from the average elasticity of transformation. The average elasticity of transformation is defined as the ratio of the average rate of growth in investment goods product relative to consumption goods product to the average rate of growth in the investment goods price relative to the consumption goods price. Rates of growth of product prices and average elasticities of transformation for 1929–1967 and for the two sub-periods, 1929–1948 and 1948–1967, are given in Table 9.

6. TOTAL FACTOR PRODUCTIVITY

The main application of estimates of real product, real factor input, and their prices is to the study of production. We have illustrated the use of relative

[34]See Solow [32] and Arrow, Chenery, Minhas, and Solow [2]. Their data are for private non-farm gross national product for the period 1909-1949. Their estimate of total factor productivity for the period 1929-1948 rises from 1.251 to 1.761 on a base of unity in 1909, for an average rate of growth of 1.8 per cent per year.

TABLE 8

GROSS PRIVATE DOMESTIC FACTOR PRICES, 1929–1967 (1958 = 1.000)

Year	1. Labor Cost "Stock"	2. Labor Cost from "Potential" Flow	3. Labor Cost from "Actual" Flow	4. Capital Cost from "Stock"	5. Capital Cost from "Potential" Flow	6. Capital Cost from "Actual" Flow
1929	0.286	0.342	0.324	0.391	0.456	0.518
1930	0.275	0.328	0.311	0.315	0.365	0.431
1931	0.249	0.295	0.273	0.279	0.324	0.397
1932	0.210	0.248	0.236	0.206	0.240	0.308
1933	0.196	0.230	0.219	0.213	0.253	0.314
1934	0.209	0.244	0.238	0.224	0.270	0.323
1935	0.220	0.256	0.248	0.284	0.342	0.393
1936	0.236	0.274	0.263	0.311	0.374	0.418
1937	0.259	0.299	0.285	0.331	0.395	0.444
1938	0.255	0.292	0.281	0.291	0.343	0.408
1939	0.265	0.303	0.290	0.331	0.391	0.438
1940	0.275	0.313	0.300	0.370	0.435	0.461
1941	0.313	0.353	0.337	0.337	0.532	0.525
1942	0.373	0.418	0.398	0.534	0.617	0.586
1943	0.436	0.484	0.459	0.631	0.730	0.653
1944	0.475	0.524	0.493	0.660	0.767	0.683
1945	0.492	0.538	0.511	0.652	0.757	0.700
1946	0.518	0.562	0.540	0.689	0.795	0.771

1947	0.570	0.614	0.594	0.745	0.842	0.802
1948	0.614	0.656	0.638	0.784	0.862	0.827
1949	0.626	0.665	0.647	0.736	0.797	0.801
1950	0.662	0.699	0.683	0.869	0.930	0.905
1951	0.723	0.758	0.742	0.945	0.999	0.964
1952	0.766	0.798	0.782	0.933	0.977	0.959
1953	0.809	0.838	0.827	0.929	0.967	0.932
1954	0.829	0.854	0.846	0.932	0.961	0.955
1955	0.872	0.893	0.880	1.011	1.037	0.996
1956	0.925	0.942	0.930	0.955	1.010	0.970
1957	0.972	0.983	0.978	1.001	1.009	0.983
1958	1.000	1.000	1.000	1.000	1.000	1.000
1959	1.060	1.048	1.042	1.069	1.067	1.028
1960	1.103	1.081	1.074	1.074	1.066	1.023
1961	1.137	1.106	1.103	1.095	1.079	1.043
1962	1.190	1.149	1.144	1.173	1.151	1.091
1963	1.236	1.185	1.180	1.211	1.179	1.110
1964	1.298	1.236	1.229	1.258	1.213	1.116
1965	1.356	1.281	1.271	1.356	1.291	1.183
1966	1.435	1.344	1.335	1.426	1.336	1.219
1967	1.504	1.397	1.387	1.395	1.283	1.171

TABLE 9

SOURCES OF GROWTH IN FACTOR PRICES AND PRODUCT PRICES; ELASTICITIES OF SUBSTITUTION AND TRANSFORMATION, 1929–1967 (ANNUAL PERCENTAGE RATES OF GROWTH)

	1929–1948	1948–1967	1929–1967
1. Labor cost			
a. Stock	4.03	4.72	4.37
b. Potential flow	3.43	3.98	3.71
c. Actual flow	3.56	4.09	3.83
2. Capital cost			
a. Stock	3.66	3.03	3.34
b. Potential flow	3.35	2.10	2.72
c. Actual flow	2.47	1.83	2.15
3. Elasticity of substitution			
a. Stock	−2.69	1.40	0.66
b. Potential flow	−16.15	1.36	0.64
c. Actual flow	−0.25	1.30	0.79
d. ACMS	−0.20	1.35	0.77
4. Consumption goods price	2.13	1.97	2.05
5. Investment goods price	2.22	1.81	2.02
6. Elasticity of transformation	6.13	−2.07	−16.10

factor proportions and relative factor prices in analyzing the responsiveness of factor proportions to factor price changes. We have also analyzed the responsiveness of product proportions to product price changes. We now consider the application of real product and real factor input to the measurement of total factor productivity. We present a number of alternative estimates of total factor productivity based on alternative conventions about the measurement of real factor input. We begin with an estimate of total factor productivity based on the actual flow of labor and capital services. We compare this estimate with alternatives based on potential flows of labor and capital services and on stocks of labor and capital.

The services of consumers' durables and producers' durables used by institutions are allocated directly to final demand so that growth in the quantities of these services does not affect growth of total factor productivity. Similarly, the services of owner-occupied dwellings and institutional structures are allocated directly to final demand. In evaluating the relative importance of growth of real factor input and of total factor productivity as sources of economic growth, it is useful to compare the relative proportions of each on the growth of real product, including and excluding capital services from the household sector. We present estimates of the relative importance of the sources of economic growth for gross private domestic product as we have defined it and for analogous gross product measures excluding household durables and structures.

Total factor productivity is defined as the ratio of real product to real factor input or, equivalently, as the ratio of the price of factor input to the product price. Growth in total factor productivity has a counterpart in growth of the price of factor input relative to the price of output. We may define a Divisia index of total factor productivity, say P, as:

$$\log \frac{P_t}{P_{t-1}} = \log \frac{Y_t}{Y_{t-1}} - \log \frac{X_t}{X_{t-1}},$$

where Y is the quantity index of total product and X is the quantity index of total factor input. Equivalently, the index of total factor productivity may be defined as:

$$\log \frac{P_t}{P_{t-1}} = \log \frac{p_t}{p_{t-1}} - \log \frac{q_t}{q_{t-1}},$$

where p is the price index of total factor input and q is the price index of total product.[35] The index of total factor productivity for 1929–1967 corresponding to the quantity index of gross private domestic product from Table 3 and the quantity index of gross private domestic factor input from Table 6 is given in Table 10.

The conventions for measurement of factor services underlying our concept of gross private domestic factor input have been employed by Jorgenson and Griliches. Our estimates differ from theirs in two significant respects: First, we have converted their index of relative utilization to an annual basis and reduced the scope of adjustments of potential flows of capital services for changes in relative utilization. Second, we have measured the flow of capital services for sectors distinguished by legal form of organization in order to provide a more detailed representation of the tax structure. These differences have an important impact on the estimate of total factor productivity.

Our conventions for the measurement of factor services are not the only ones employed in the measurement of total factor productivity. Denison and Solow use a stock concept of capital input, measuring neither changes in relative utilization nor changes in the quality of capital services due to changes in the composition of the capital stock.[36] Denison weights persons engaged by an index of labor quality that incorporates the effects of growth in educational attainment but differs in a number of important respects from the index we have used.[37] Denison also adjusts man-hours for changes in labor efficiency that accompany changes in hours per man.[38] Solow uses unweighted man-hours, omitting the effects of changes in the composition of the labor force on the quantity of labor input.[39] Kendrick adjusts labor and capital input for changes in the industrial composition of labor force and capital stock.[40] However, changes within an industrial sector due to shifts in composition are not included in his measures of real factor input.

To provide a basis for comparison of our estimates of total factor productivity with estimates that result from alternative conventions for the measurement of real factor input, we present measures of total factor productivity based on potential service flows and on stocks of labor and capital in Table 10. The first variant on our estimate of total factor productivity omits the relative utilization adjustment for capital, the second omits the relative utilization adjustment for

[35]For further discussion of this index of total factor productivity, see Jorgenson and Griliches [23], especially pages 250–254. The Divisia index of total factor productivity described in the text is a discrete approximation to the continuous Divisia index discussed by Jorgenson and Griliches.

[36]See Denison [10], pages 94–99, and Solow [32], page 315.

[37]See Denison [10], especially pages 67–72.

[38]See Denison [10], especially pages 35–41.

[39]See Solow [32], page 315.

[40]See Kendrick [26], especially pages 252–289.

TABLE 10

TOTAL FACTOR PRODUCTIVITY, 1929–1967 (1958 = 1.000)

Year	1. Labor and Capital Services	2. Actual Labor Services; Potential Capital Services	3. Potential Labor and Capital Services	4. Potential Labor Services; Capital Stock	5. Labor and Capital Stock	6. Actual Labor Services; Capital Stock	7. Unweighted Man-hours; Capital Stock
1929	0.726	0.685	0.707	0.664	0.599	0.644	0.530
1930	0.680	0.631	0.652	0.614	0.555	0.595	0.496
1931	0.657	0.600	0.628	0.591	0.536	0.565	0.483
1932	0.614	0.550	0.567	0.533	0.484	0.517	0.445
1933	0.604	0.548	0.564	0.527	0.480	0.511	0.443
1934	0.636	0.586	0.596	0.552	0.504	0.543	0.487
1935	0.668	0.627	0.640	0.593	0.543	0.581	0.518
1936	0.714	0.679	0.696	0.645	0.592	0.629	0.556
1937	0.738	0.699	0.719	0.669	0.615	0.650	0.571
1938	0.734	0.679	0.695	0.649	0.599	0.634	0.567
1939	0.763	0.724	0.743	0.694	0.642	0.676	0.601
1940	0.788	0.766	0.786	0.736	0.682	0.716	0.638
1941	0.826	0.828	0.851	0.799	0.744	0.777	0.692
1942	0.839	0.855	0.882	0.832	0.778	0.807	0.715
1943	0.872	0.912	0.941	0.888	0.834	0.860	0.758
1944	0.925	0.969	1.005	0.946	0.893	0.913	0.807
1945	0.944	0.973	1.004	0.945	0.896	0.916	0.822
1946	0.898	0.908	0.930	0.878	0.836	0.857	0.790

1947	0.862	0.878	0.895	0.852	0.815	0.836	0.782
1948	0.882	0.896	0.911	0.876	0.843	0.862	0.814
1949	0.892	0.890	0.904	0.875	0.845	0.861	0.817
1950	0.938	0.948	0.961	0.935	0.906	0.922	0.882
1951	0.946	0.960	0.971	0.949	0.923	0.938	0.902
1952	0.949	0.956	0.967	0.949	0.927	0.938	0.904
1953	0.968	0.982	0.990	0.974	0.954	0.966	0.938
1954	0.974	0.977	0.982	0.969	0.953	0.964	0.942
1955	1.006	1.022	1.031	1.020	1.006	1.012	0.989
1956	0.993	1.010	1.018	1.011	1.001	1.004	0.986
1957	0.998	1.009	1.012	1.009	1.002	1.006	0.996
1958	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1959	1.018	1.034	1.038	1.039	1.046	1.035	1.039
1960	1.019	1.036	1.040	1.043	1.056	1.039	1.048
1961	1.032	1.046	1.048	1.054	1.072	1.053	1.068
1962	1.061	1.085	1.088	1.097	1.120	1.094	1.114
1963	1.076	1.104	1.106	1.119	1.147	1.116	1.141
1964	1.091	1.130	1.134	1.151	1.185	1.147	1.177
1965	1.115	1.157	1.162	1.187	1.226	1.181	1.215
1966	1.129	1.174	1.178	1.211	1.258	1.207	1.249
1967	1.114	1.157	1.162	1.204	1.256	1.199	1.247

labor; the second variant is based on potential service flows for both labor and capital input. The third variant omits the quality adjustment for capital, while the fourth omits the quality adjustment for labor, providing a stock measure of total factor productivity. Two final variants provide combinations of alternative measures of labor input with the stock measure of capital. The fifth combines actual labor input with the stock of capital, while the sixth combines unweighted actual man-hours with capital stock.

TABLE 11
GROWTH IN TOTAL FACTOR PRODUCTIVITY, 1929–1967 (AVERAGE ANNUAL RATES OF GROWTH)

	1929–1948	1948–1967	1929–1967
1. Actual labor and capital services	1.03	1.23	1.13
2. Actual labor services; potential capital services	1.42	1.35	1.38
3. Potential labor and capital services	1.34	1.28	1.31
4. Potential labor services; capital stock	1.46	1.67	1.56
5. Labor and capital stock	1.80	2.10	1.95
6. Actual labor services; capital stock (Denison)	1.54	1.74	1.64
7. Man-hours and capital stock (Solow and ACMS)	2.26	2.25	2.25

It is obvious from a comparison of the alternative estimates of total factor productivity given in Table 10 that the results are highly sensitive to the choice of conventions for measuring real factor input. The effects of varying the conventions are summarized for the periods 1929–1948, 1948–1967, and 1929–1967 in Table 11; geometric average annual rates of growth are given for each variant of total factor productivity.

Finally, to evaluate the relative importance of growth in real factor input and growth in total factor productivity as sources of economic growth, we consider the relative proportion of growth in real factor input for two alternative concepts of real product—including and excluding the capital input of the household sector. Geometric average annual rates of growth are given for real product and real factor input, including and excluding household capital services, for 1929–1967 in Table 12. The relative proportion of growth in total factor productivity in the growth of real product is also provided for both concepts of real product.[41]

We find that the growth in real factor input predominates in the explanation of the growth of real product for the period 1929–1967 and for each of the sub-periods, 1929–1948 and 1948–1967. These findings are directly contrary to those of Abramovitz [1], Kendrick [26], and Solow [32], in earlier studies of productivity change. We have estimated real factor input on the basis of capital stock and actual man-hours, the conventions used by Solow and subsequently adopted by Arrow, Chenery, Minhas, and Solow [2], for 1929–1967. The resulting

[41]Denison [10], pages 148–149, employs real national income, Solow [32], page 315, employs private, non-farm, gross national product, and Kendrick [26], pages 328–342, employs both gross national product and net national product.

TABLE 12

THE RELATIVE IMPORTANCE OF PRODUCTIVITY CHANGE, 1929–1967 (AVERAGE ANNUAL RATES OF GROWTH)

	1929–1948	1948–1967	1929–1967
1. Gross private domestic product			
Real product	2.37	3.96	3.16
Real factor input	1.34	2.73	2.04
Total factor productivity	1.03	1.23	1.13
Relative proportion of productivity change	0.43	0.31	0.36
2. Gross private domestic product, excluding household capital services			
Real product	2.54	3.70	3.12
Real factor input	1.54	2.28	1.91
Total factor productivity	1.00	1.42	1.21
Relative proportion of productivity change	0.39	0.38	0.39

estimates of the distribution of the growth of real product between growth in real factor input and total factor productivity are comparable to those of Solow's earlier study. On this basis total factor productivity grows at the average rate of 2.25 per cent per year while real factor input grows at 0.91 per cent per year. Our estimates, given in Table 12, are that total factor productivity grows at 1.13 per cent per year and real factor input at the rate of 2.04 per cent per year. Total factor productivity accounts for 36 per cent of the growth of real product, while real factor input accounts for 64 per cent of output growth.

We have also extended estimates of real factor input based on capital stock and actual labor input, the conventions adopted by Denison [10], through 1967. Denison's estimates of the growth of labor input are conceptually similar to our own and his empirical results are closely comparable to ours. We find that estimates of real factor input based on the conventions used by Denison suggest that total factor productivity grows at the average rate of 1.64 per cent per year while real factor input grows at 1.52 per cent per year. The discrepancy between our estimates, given in Table 12, and those of Denison is accounted for almost entirely by our adjustments of the measure of capital input for quality change and relative utilization. Denison has incorporated about half the growth in real factor input over and above the growth of capital stock and actual man-hours into his estimates of real factor input.

Finally, although growth in real factor input predominates in the growth of real product, we estimate that changes in total productivity are substantial for 1929–1967 and for both the sub-periods we have considered. The conclusion of Jorgenson and Griliches [23] that productivity growth is negligible must be revised accordingly. The main differences between our estimates and those of Jorgenson and Griliches are in the measurement of capital. We have incorporated the effects of taxation in greater detail through separation of property compensation by legal form of organization. However, the discrepancy between our empirical results and those of Jorgenson and Griliches is primarily accounted for by our measurement of the relative utilization of capital. We have reduced the scope of the adjustment for relative utilization by confirming it to depreciable assets in the corporate and non-corporate sectors. Second, incorporation of

annual estimates of capacity to consume electricity and actual electricity consumption results in the allocation of the total growth in relative utilization for the period 1929–1967 to the period 1929–1948. In the relative utilization adjustment of Jorgenson and Griliches, almost all of the growth in relative utilization was allocated to the period 1945–1965.

7. Summary and Conclusion

In this paper we have attempted to provide a conceptual basis for separating social product and social factor input into price and quantity components. To test the feasibility of our accounting framework we have measured real product and real factor input for the United States from 1929–1967. We conclude that estimates of real factor input paralleling the real product estimates in the United States national accounts are feasible. The data required for estimation of real product are the same as those required for perpetual inventory estimates of capital stock together with data on property compensation by legal form of organization and information on the tax structure for property income.

Fully satisfactory estimates of real factor input will require much additional research. In measuring labor input, data on persons engaged should include estimates of the number of unpaid family workers, such as those of Kendrick [25, 26]. Estimates of man-hours for the different components of the labor force should be compiled on a basis consistent with data on persons engaged, as Kendrick [25, 26] has done. The weakest link in the chain of imputations linking labor input to the underlying data on man-hours and employment is the adjustment of labor input for the intensity of effort, along the lines suggested by Denison [10]. Additional evidence on this adjustment is given by Denison [11] for the United States and for Europe. The validity of estimates of intensity of effort must be tested through the study of variations in labor income by hours worked, holding other characteristics of labor input constant. Finally, the quality adjustments for the labor force should be expanded to incorporate changes in the relative number of hours worked. The quality adjustments should also incorporate characteristics of the labor force other than educational attainment such as age, race, sex, occupation, and industry. Similar improvements in the measurement of capital input are discussed in our previous paper.[42]

Detailed accounting measurements of real product and real factor input will open up many new possibilities for the study of production. We have analyzed the responsiveness of factor proportions to changes in relative factor prices and the responsiveness of product proportions to changes in relative product prices. Average elasticities of substitution between factors and transformation between products vary considerably between the sub-periods 1929–1948 and 1948–1967. Estimates of these elasticities depend critically on the method for measurement of factor input. Our estimates of the elasticity of substitution, based on actual flows of labor and capital input, are strikingly similar to those of Arrow, Chenery, Minhas, and Solow [2], based on very different conventions of measurement. However estimates of the elasticity of substitution based on stocks

[42] Christensen and Jorgenson [5].

of labor and capital or potential flows of labor and capital services differ substantially from these estimates.

We have measured total factor productivity in the United States for the period 1929–1967. This study extends the analysis of productivity change by Jorgenson and Griliches [23]. First, we have provided measurements for a considerably longer time period than the time period 1945–1965 used in their study. Second, we have analyzed the growth of real factor input in more detail. One important change is the refinement of the measurement of relative utilization of capital by incorporation of annual data on capacity to consume electricity and on actual electricity consumption. A second important change is the separation of property compensation by legal form of organization. This change enables us to incorporate the effects of taxation of income from capital in a more satisfactory way.

Although growth in real factor input predominates in the growth of real product, we estimate that changes in total factor productivity are substantial for 1929–1967 and for both the sub-periods we have considered. The conclusion of Jorgenson and Griliches that productivity growth is negligible must be revised accordingly.

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REAL PRODUCT, REAL FACTOR INPUT, AND PRODUCTIVITY IN ITALY, 1952-1973

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REAL PRODUCT, REAL FACTOR INPUT, AND PRODUCTIVITY IN ITALY, 1952-1973

by

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The measurement of social product in current and constant prices is well established in accounting practice. Official social accounts for Italy, which closely follow standard practice, are published regularly by the Istituto Centrale di Statistica. Each delivery of social product to final demand involves a commodity or service flow that is separated into price and quantity components. Quantities and prices of individual commodities and services are combined into indexes of real product and its price or implicit deflator.

An analysis of the sources of productivity change requires the measurement of social factor outlay in current and constant prices. The conceptual basis for separation of factor outlay into price and quantity components is identical to that for social product. Each outlay on factor services must be separated into price and quantity components. Prices and quantities of the individual factor services are combined into indexes of real factor input and its price. For example, the value of labor services can be divided between the wage rate and the quantity of labor time. The product of the two is the outlay on labor services or labor compensation.

Despite the essential similarity between concepts of real product and real factor input, the measurement of social factor outlay in constant prices is not well established in social accounting practice. The chief problem is the measurement of capital input in real terms. Recently,

Christensen and Jorgenson (1969) have provided a conceptual basis for measuring real capital input. Their method involves separating outlay on capital services into price and quantity components using an accounting imputation. The method of imputation is based on the correspondence between asset prices and service prices implied by the equality between the value of an asset and the discounted value of its services. Christensen and Jorgenson (1970), (1973a), (1973b) integrated their method for measuring real capital input into a complete accounting system for the private sector of a national economy.

In this paper we follow the methods of Christensen and Jorgenson in developing estimates of real product and real factor input for the private sector of the Italian economy. We employ our estimates to study productivity change in the private sector of the Italian economy in the 1952-1973 period. We present estimates of changes in manhour productivity and total factor productivity. We also derive a relationship between manhour and total factor productivity.

Our estimates averaged over the period 1952-1973 yield the following conclusions for the private sector of the Italian economy: The economy grew at a rate of 5.2% per year. More than half of this growth can be attributed to increases in real factor input: 1.0% has been due to growth of labor input, 1.8% has been due to growth of capital input, while 2.5% has been due to increases in total factor productivity. Manhour productivity has increased at 5.2% per year. Of this total 2.5% resulted from increases in total factor productivity, 0.9% from increased quality of the labor force, 0.1% from increased quality of the capital stock, and 1.6% from increases in the capital-labor ratio.

2. The Production Account in Current Prices

Our production account is for the private sector of the Italian economy. The general government sector is excluded. It would also be desirable to exclude government enterprises. However, it is not possible to identify separately the portions of private GNP or gross private domestic investment which are actually due to government enterprises. Thus we will use the term private domestic sector to refer to private domestic business enterprises, plus households, plus government enterprises.

Our concepts of revenue and outlay are from the producer point of view. The value of output is net of taxes on output but the value of input is gross of taxes on input. Thus we divide indirect business taxes into two categories. We exclude from the value of production all indirect business taxes which are viewed as charges against revenue, such as excise or sales taxes. But we include indirect business taxes charged to the producer as part of outlay in obtaining services from productive factors, such as property taxes. In effect we increase factor cost by indirect business taxes related to the level of input of productive factors. We treat government subsidies to the business sector as negative indirect business taxes charged against revenue. Thus we add subsidies to arrive at the value of output from the producer point of view.

In the Italian national income and product accounts an estimate of the services of owner-occupied housing is included in the product of the private sector. The flow of capital services resulting from investment in housing by owner-occupiers is not, however, recorded in market transactions. The value of this service flow must be imputed from data on rental values for tenant-occupied housing. In the Italian accounts the treatment of capital services from consumer durables is not symmetrical with that of housing.

Purchases of consumer durables are treated as part of personal consumption expenditures rather than investment, and the service flow from these durables, unlike housing services, is not included in GNP.

We treat the services of owner-utilized consumer durables symmetrically with the services of owner-occupied housing. Purchases of new consumer durables are included in private investment, rather than consumption. This change from the conventions of the Italian national income and product accounts leaves the value of total product unaltered. We then impute the value of services of consumer durables using the cost of capital implicit in the service flow for owner-occupied housing. We add the resulting service flow to the product of the private sector.

Given our definitions of output and input, we may describe more explicitly the measurement of gross private domestic product and gross private domestic factor outlay. The value of gross product is defined as gross national product less GNP originating in general government, less rest of world GNP, plus services of consumer durables, less indirect business taxes not related to factor outlay, plus subsidies. The resulting value of gross private domestic product for the year 1963 is presented in Table 1.

The value of gross private domestic factor outlay is equal to the value of gross private domestic product by definition. The value of factor outlay is equal to gross national income, a category in the Italian national accounts which includes capital consumption allowances, less government and rest of world GNP, plus services of consumer durables, plus indirect business taxes related to factor outlay. Capital consumption allowances are included since they are part of the outlay for capital services and are included in

the rental value of capital services. The resulting value of gross private domestic factor outlay for the year 1963 is given in Table 1. A detailed breakdown of our treatment of Italian taxes, along with figures for 1963, is presented in Tables 1a and 1b.

In separating the values of gross product and gross factor outlay into price and quantity components, we find it useful to divide total product among consumption and investment final sales, net exports, and changes in business inventories. We divide total factor outlay between labor and capital services. We combine the final sales of durable goods and structures to business and government enterprises with final sales of consumer durables and refer to the total as final sales of investment goods.

Our definition of services output includes the services of consumer durables along with services output included in the Italian accounts. The output of the foreign and general government sectors consists entirely of services, so that we define the output of services by the private domestic sector as services included in gross national product, less the product of foreign and general government sectors, plus the services of consumer durables.

We combine the private domestic sector's output of services with final sales of nondurable goods and refer to the total as final sales of consumption goods.

Our definition of gross domestic business product from the producer point of view excludes indirect business taxes not considered to be charges related to levels of factor inputs. The excluded taxes are mainly sales and excise taxes. Subsidies are netted against these retail business taxes. We refer to the results as "retail taxes less subsidies."

Table 1

Production Account, Gross Private Domestic Product and Factor Outlay, 1963
(billion current lire)

	Product	
1.	Gross National Product (ACN[a], p. 3)	31,261
2.	- Wages and salaries in general government (ACN, p. 104)	2,940
3.	- Capital Consumption Allowances and Property Income of general government (ACN, p. 104)	198
4.	- Rest of world gross national product (ACN, p. 5)	121
5.	+ Services of consumer durables (our imputation)	1,815
6.	- Taxes not related to factor outlay (computed from ACN, pp. 33-41, see Table 1a below)	3,199
7.	+ Subsidies (ACN, p. 33)	342
8.	= Gross private domestic product	26,960
	Factor Outlay	
1.	National Income, gross of capital consumption allowances (ACN, p. 18)	27,800
2.	+ Services of consumer durables (our imputation)	1,815
3.	- GNP originating in general government (2+3 above)	3,138
4.	- Direct taxes per the national accounts (ACN, p. 41)	1,770
5.	+ Direct taxes, our estimate (see Table 1a below)	1,490
6.	+ Indirect taxes (total taxes per the national accounts minus our estimate of direct taxes, see Table 1a below)	4,083
7.	- Taxes not related to factor outlay (see Table 1b below)	3,199
8.	- GNP originating in rest of world (ACN, p. 5)	121
9.	= Gross private domestic factor outlay	26,960

[a] Annuario di Contabilita Nazionale, Istituto Centrale di Statistica.

Table 1a

Taxes in the Italian Economy (billion current lire)

National Income Accounts (ACN)	
Direct Taxes on Corporations	547.3
Other Direct Taxes	1,222.6
Indirect Taxes	3,802.6
Total Taxes	5,572.5
Christensen-Cummings-Norton Accounting System	
Business Income Taxes	656.7
Personal Income Taxes	773.0
Inheritance Tax	60.2
Direct Taxes	1,489.9
Indirect Taxes (see Table 1b below)	4,082.6
Total Taxes	5,572.5

Table 1b

Indirect Taxes

1.	Land Tax	6.3
2.	Buildings Tax	17.0
3.	Ordinary Property Tax	0.1
4.	Extraordinary Progressive Property Tax	12.3
5.	Extraordinary Proportional Property Tax	0.2
6.	Extraordinary Tax on Corporate and Agency Property	0.3
7.	Family Automobile Tax	36.2
8.	Provincial Land Surtax	31.7
9.	Provincial Buildings Surtax	44.9
10.	Provincial Improvement Contribution	0.3
11.	Communal Tax on Leasehold Value	3.4
12.	Communal Land Surtax	34.7
13.	Communal Buildings Surtax	40.3
14.	Communal License Tax	5.4
15.	Communal Signs Tax	4.2
16.	Communal Patents Tax	1.6
17.	Communal Expresso Machine Tax	1.3
18.	Communal Improvement Contribution	2.8
19.	Communal Sewer Tax	7.1
20.	Communal Tax on Increase in Land Value	3.5
21.	Communal Billiard Table Tax	0.0
22.	Automobile Tax	64.4
23.	Registration Tax	191.3
24.	Stamp Tax	171.2
25.	Other Stamp Tax	11.4
26.	Registration and Stamp Substitute Tax	21.7
27.	Mortgage Tax	46.7
28.	Additional Registration and Mortgage Tax	21.6
29.	Tax on Government Concessions	45.1
30.	Advertising Tax	8.0
31.	Special Tax	45.9
32.	Communal Tax on Advertixing	2.4
33.	Provincial Tax on Animal-drawn Vehicles	0.0
	Total Indirect taxes related to factor outlay	883.3

Table 1b (continued)

1.	Communal Garbage Collection Duty	15.9
2.	Communal Dog Fee	2.5
3.	Obligatory Duty	0.0
4.	Other Firm Taxes	8.0
5.	Transactions Tax (IGE)	1060.2
6.	Compensatory Tax	100.1
7.	Manufacturing Tax and Border Surtax on Oil	537.2
8.	Customs Duties	341.0
9.	Mercury Manufacturing Tax	0.0
10.	Cement Manufacturing Tax	0.0
11.	Special Tax on Purchase of Certain Products	0.0
12.	Unique Tax on Games of Skill and Fortunetelling	3.9
13.	Tollway Duty	0.0
14.	Manufacturing Taxes	228.4
15.	Taxes on Government Monopolies	555.2
16.	Other Consumption Taxes	119.1
17.	Tax on Lotto, Lotteries, and Fortunetelling	30.8
18.	Reimbursement from National indirect taxes	-136.8
19.	Taxes of Other Central Government Agencies	18.0
20.	Communal Consumption Tax	245.5
21.	Communal Touring and Cures Tax	0.5
22.	Communal Tax on Occupation of Public Spaces	9.8
23.	Communal Casino Tax	0.0
24.	Other Communal Indirect Taxes	0.0
25.	Provincial Tax on Occupation of Public Spaces	0.3
26.	Regional Tax on Production of Electricity	1.1
27.	Regional Casino Tax	4.0
28.	Regional Other	0.0
29.	Other Local Government Agencies Taxes	0.7
30.	Statistical Discrepancy	53.9
	Total Indirect Taxes not related to factor outlay	3,199.3

If retail taxes were assessed only on the basis of deliveries to final demand, we could allocate them directly. In fact a substantial portion of sales and excise taxes falls on deliveries to intermediate demand. A completely satisfactory allocation of these taxes would require a detailed input-output analysis. However, the data required to carry out this analysis are unavailable. As a first approximation we have allocated retail taxes less subsidies proportionally to final sales of investment goods and consumption goods.

The value of factor outlay in the private domestic sector includes the labor compensation of all employees less compensation of employees in general government, plus the implicit labor compensation of self-employed persons and unpaid family workers. We take data on compensation of private sector employees, and of general government employees from the Annuario di Contabilita Nazionale. We then estimate labor compensation of the self-employed by imputing to them the average annual wage of all private sector employees. We compute the average annual wage of private sector employees as the ratio of compensation to employees in the private sector. Estimates of total and government employment and self-employed (independent workers) are taken from series provided in Annali di Statistica. Unpaid family workers data is taken from OECD Labor Force Statistics; early years are extrapolated using this information. We estimate the labor compensation of unpaid family workers by imputing to them one-fourth of the average annual wage of all

business sector employees.[1]

All factor outlay not allocated to labor is allocated to capital. Specifically, the value of outlay on capital services includes the following: property income of self-employed persons, profits, rentals, and interest; capital consumption allowances; business transfer payments; indirect business taxes that are part of the outlay on productive factors, such as motor vehicle licenses and property taxes; and the imputed value of the services of consumer durables. Gross private domestic product and factor outlay in current prices for 1952-1973 are given in Table 2.

Total product in Table 2 is broken down into domestic sales of investment goods, domestic sales of consumption goods, changes in business inventories, and net exports. Total product is also divided between labor compensation and property compensation.

3. Price and Quantity Index Numbers for Total Product

We follow Christensen and Jorgenson (1970) in using discrete approximations to the Divisia Index to construct aggregate quantity indexes. We define the rate of growth of the quantity aggregate q_t as

$$\log q_t - \log q_{t-1} = \Sigma \bar{w}_{it}(\log q_{it} - \log q_{i,t-1})$$

where the weights ($\bar{w}_{it}$) are arithmetic averages of the realtive value shares in the two periods

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[1] This method of imputation is similar to that proposed by Christensen (1971) for the U.S. Christensen argued that imputing the average annual wage of employees to the total number of proprietors provided a good estimate of the implicit labor compensation for both self-employed persons and unpaid family workers. As in the cases of Korea and France, we decided that some additional compensation must be imputed to the sizeable number of Italian unpaid family workers.